JC772 U.S. PTO 08/17/00

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	050-96-017 C2 (2158.4700 C2)
First Named Inventor or Application Identifier	
JOHN STANKO, ET AL.	
Express Mail Label No.	

JC864 U.S. PTO 09/640063 08/17/00

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: Assistant Commissioner for Patents
Box Patent Application
Washington, DC 20231

1. [X] Fee Transmittal Form *(Submit an original, and a duplicate for fee processing)*
2. [X] Specification — *Total Pages* 28
3. [X] Drawing(s) *(35 USC 113)* — *Total Sheets* 5
4. [X] Oath or Declaration — *Total Pages* 3
   - a. [ ] Newly executed (original or copy)
   - b. [ ] Unexecuted for information purposes
   - c [X] Copy from a prior application (37 CFR 1.63(d)) *(for continuation/divisional with Box 17 completed)* ***[Note Box 5 below]***
     - i. [ ] DELETION OF INVENTOR(S) Signed Statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
5. [X] Incorporation By Reference *(useable if Box 4c is checked)* The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4c, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.
6. [ ] Microfiche Computer Program *(Appendix)*
7. Nucleotide and/or Amino Acid Sequence Submission *(if applicable, all necessary)*
   - a. [ ] Computer Readable Copy
   - b. [ ] Paper Copy (identical to computer copy)
   - c. [ ] Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

8. [ ] Assignment Papers (cover sheet & document(s))
9. [ ] 37 CFR 3.73(b) Statement *(when there is an assignee)* [X] Power of Attorney
10. [ ] English Translation Document *(if applicable)*
11. [ ] Information Disclosure Statement (IDS)/PTO-1449 [ ] Copies of IDS Citations
12. [X] Preliminary Amendment
13. [X] Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
14. [ ] Small Entity Statement(s) [ ] Statement filed in prior application Status still proper and desired
15. [ ] Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
16. [ ] Other: ______

17. If a CONTINUING APPLICATION, *check appropriate box and supply the requisite information:*
[X] Continuation [ ] Divisional [ ] Continuation-in-part (CIP) of prior application No. 09/507,404 filed February 18, 2000.

18. CORRESPONDENCE ADDRESS

[X] Customer Number or Bar Code Label — 000128 (Insert Customer No. or Attach bar code label here) — or [ ] Correspondence address below

NAME					
Address					
City		State		Zip Code	
Country		Telephone		Fax	

[+]

CLAIMS	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
	TOTAL CLAIMS (37 CFR 1.16(c))	1-20 =	0	X $ 18.00 =	$ 0.00
	INDEPENDENT CLAIMS (37 CFR 1.16(b))	1-3 =	0	X $ 78.00 =	$ 0.00
	MULTIPLE DEPENDENT CLAIMS (if applicable) (37 CFR 1 16(d))			$260.00 =	$ 0.00
				BASIC FEE (37 CFR 1.16(a))	$ 690.00
				Total of above Calculations =	$ 690.00
	Reduction by 50% for filing by small entity (Note 37 CFR 1.9, 1.27, 1.28).				
				TOTAL =	$ 690.00

19. Small entity status
    - a. ☐ A Small entity statement is enclosed
    - b. ☐ A small entity statement was filed in the prior nonprovisional application and such status is still proper and desired.
    - c. ☐ Is no longer claimed.

20. [X] A check in the amount of $ 690.00 to cover the filing fee is enclosed.

21. ☐ A check in the amount of $ __________ to cover the recordal fee is enclosed.

22. The Commissioner is hereby authorized to credit overpayments or charge the following fees to Deposit Account No. 06-1205:
    - a. [X] Fees required under 37 CFR 1.16.
    - b. [X] Fees required under 37 CFR 1.17.
    - c. ☐ Fees required under 37 CFR 1.18.

09/641,653

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED	
NAME	Daniel S. Glueck - Registration No. 37,838
SIGNATURE	Daniel Glueck
DATE	August 17, 2000

DSG\tnt

050-96-017 C2 (2158.4700 CII) PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	) :	Examiner: T. Wesson
JOHN STANKO, ET AL.	) :	Group Art Unit: 3641
Appln. No.: Unassigned (Continuation of Appln. No. 09/507,404 filed February 18, 2000)	) :) :) :	
Filed: August 17, 2000	) :	
For: HYBRID DEICING SYSTEM AND METHOD OF OPERATION	) :)	August 17, 2000

09640635.081700

Assistant Commissioner for Patents
BOX PATENT APPLICATION
Washington, DC 20231

PRELIMINARY AMENDMENT

Sir:

Prior to examination on the merits, please amend the above-identified application as follows:

IN THE SPECIFICATION:

Please amend the specification as follows:

Page 1,

Before Line 1, insert --This application is a continuation of Application No. 09/507,404 filed February 18, 2000, which is a continuation of Application No. 08/877,272

filed June 17, 1997, Patent No. 6,047,926, which claims the benefit of U.S. Provisional Application No. 60/022,508 filed June 28, 1996.--.

IN THE CLAIMS:

Please cancel Claims 2 through 89 without prejudice to or disclaimer of the subject matter recited therein.

REMARKS

This is a continuation application of Application No. 09/507,404 filed February 18, 2000 (the "'404 Application"), which is a continuation of Application No. 08/877,272 filed June 17, 1997, Patent No. 6,047,926, which claims the benefit of U.S. Provisional Application No. 60/022,508 filed June 28, 1996.

Claim 1 is pending, with Claim 1 being independent. Claims 2 through 89 have been cancelled without prejudice.

The specification has been amended.

Applicants claim priority under 35 U.S.C. § 119 based upon U.S. Patent Application No. 60/022,508 filed June 28, 1996, and respectfully request acknowledgment of this claim.

Applicants submit that this application is in condition for allowance, and a Notice of Allowance is respectfully requested.

All correspondence should continue to be directed to the below-listed address.

Respectfully submitted,

Daniel Hlwek

Attorney for Applicants

Registration No. 37,838

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DSG\tnt

050-96-017

Hybrid Deicing System And Method Of Operation

Related Application

This application claims the benefit of and priority to earlier filed US provisional application for a Glycol Air Deicing System serial number filed June 17, 1996.

Field of invention

This invention is related to system for deicing aircraft and more particularly to a glycol/air coaxial stream deicing system wherein glycol and forced air are applied as a specially formed glycol stream within a forced air stream. The special stream is charged to hydronamically dislodge and remove ice or other frozen deposits from the aircraft.

Background

Prior forced air deicing systems inject the glycol in an air stream air causing the glycol to atomized and dispersed in the air. Such streams lack the cleaning capacity to dislodge and remove ice from aircraft wings.

Conventional aircraft deicing systems consist of ground or truck mounted spray systems which apply hot (180°F) deicing fluid (a mixture of glycol and water) at rates up to 60 gpm to the aircraft surfaces. This thermal process is very effective in quickly melting the snow or ice from these surfaces, i.e. wings, etc. However, glycol is expensive and toxic creating significant economic and waste management problems for airline and airport operators. The life cycle cost of deicing glycol (i.e. Type I ethylene or propylene glycol) includes costs associated with its buying, storing, handling, heating, applying, collecting and reprocessing or disposal. Various deicing systems using little or no glycol have been tried and to date these systems have demonstrated limited effectiveness. Therefore, they have not gained acceptance by commercial deicing operators.

Ground deicing of aircraft is an important step in preparing aircraft for safe flight during snow, ice and frost weather conditions. Accumulation of these winter products on aircraft surfaces (wings, tail and rudder) disturbs the aerodynamic performance of these-surfaces creating unstable flight conditions. While conventional hot deicing fluid washdown of aircraft is very effective in removing these accumulations, glycol is expensive and toxic. Furthermore, the deicing process takes time which causes flight delays during the winter months. This combination of cost, waste management and flight delays creates a significant economic burden for the airlines during winter operations. Therefore, a deicing process that is efficient, i.e. sharply reduces glycol usage and deicing cycle time, is in high demand by the airline industry.

Conventional aircraft deicing by hot deicing fluid (Type I) washdown from ground or mobile boom systems has been in use for decades with no basic changes to this technology other than refinements to the deicing fluid heating and application systems. Some of the patents covering conventional deicing and its refinements are as follows: 1) US Patent 3,243,123, to D. M. Ingraham, et. al., issued Mar. 29,1966; US Patent 4,073,437 Thornton-Trump, issued Feb. 14, 1978; 4,826,107 to Thornton-Trump, issued May 2, 1989 and US Patent 5,028,017, to Simmons, et al., issued Jul. 2, 1991. Other publications describe various deicing systems, (some of which are believed to have been tested) to improve the deicing process, either by reducing or eliminating the use of glycol, or by applying glycol in a more efficient manner such that the glycol usage is reduced for instance : US Patent 5,244,168 to Williams, issued Sep. 14, 1993 for A Methodology And Apparatus For Forced Air Aircraft Deicing and US Patent 5,104,068 to Krilla et al., issued Apr. 14, 1992

Forced air deicing ("hot air blasts) has been used by the US Air Force for decades. At Air Force bases such as Elmendorf in Alaska, operators use deicing trucks that have an add-on forced air system. Landoll is one company that modifies deicer trucks with forced air add-on for Air Force use. These Landoll add-on systems, use air

from a Garrett (now AlliedSignal) APU that is plumbed to a second (non gylcol carrying) nozzle located along with the conventional deicing fluid nozzle(s) at a boom basket. Forced air is used to remove much of the snow from military aircraft followed by conventional fluid deicing. This process, which extends deicing cycle time, is viable for the Air Force because they are typically not constrained by strict time schedules, like commercial airlines, and glycol usage is reduced.

Deicing fluid entrained in air has been know for a number of years, see for instance US patent 2,482,720 Prevention of Ice Formation in Air Intakes on Aircraft and Other Fast Moving Vehicles," U.S. Pat. No. 2,482,720 (1949) and Palmatier, "Fan Deicing or Anti-Icing Means", U.S. Pat. No. 2,406,473 (1946).

Referring now to Fig. 1, that shows an illustration of prior art forced air deicing system of the type disclosed in US Patent 5,244,168, that injects glycol A at right angles to the primary flow axis of an airstream B , generally producing what is described in that patent as "a well-dispersed atomized spray pattern" (col 7 line 35) or a "spray pattern of a high speed colloidal suspension of deicing fluid in air"(claim 1, lines 21-22). This patent also requires the uses of a "plurality of sources of deicing fluid." (see col 2, line 34 col line 32).

Various airline operators have indicated glycol injected at right angle to the primary axis of the airstream, as is shown in Fig. 1, reduces the effectiveness of forced air deicing. The glycol mixes and atomizes in the airstream. The energy transfer process associated with the mixing and atomizing reduces the kinetic energy of the airstream which reduces the effectiveness of the air stream/glycol mixture to dislodge snow and ice that is frozen to or adhered to an aircraft. Thus, this atomization process reduces the effectiveness of the airstream in breaking loose snow and ice that is frozen to or adhered to an aircraft surface and also reduces the effectiveness of the airstream in moving heavy, wet snow. In addition, the mixture of atomized glycol and high velocity air adds more wetness to the snow further inhibiting the removal of wet snow.

Another novel deicing technique developed by InfraTek Radiant Energy Corporation uses gas-fired infra-red heaters built into the interior structure of a large prefab type hangar to melt ice from the aircraft surfaces. Two fundamental problems have surfaced with this deicing process. First, the frequency of the infra red heaters is such that snow melts slowly extending the deicing cycle time. Second, testing to date shows that melting ice from the upper surfaces of the aircraft often re-freezes on the lower surfaces not exposed to the infra-red rays.

US Patent 5,104,068 Krilla et al. for a describes an apparatus for both de-icing and anti-icing an aircraft in one "pass". The apparatus consists of articulated booms on each side of the aircraft to be processed. These booms are such that they extend over the entire length of each wing and each has two series of nozzles. One set is for dispensing a deicing fluid mixture and the other set of nozzles dispenses anti-icing fluid. There is also a set of booms underneath the aircraft for processing the lower aircraft surfaces. The patent also describes the use of different mixtures of pressurized air, water and glycol (Type I) with the mixture varied in accordance with the particular weather conditions. The apparatus and process described above are commercially known by the name "Whisper Wash" expected to be field demonstrated during the winter of 1996-7. Benefits expected to be realized presumably include, reduced glycol usage and reduced de-ice/anti-ice cycle time.

Summary of the Invention

This invention overcomes the disadvantage of the prior systems and provides a new hybrid deicing system that produces high velocity specially formed coaxial stream of Type I glycol or Type I glycol and water and air for efficiently and effectively removing ice from an aircraft. This invention ("hybrid deicing "), utilizing two fluid flow technologies and a unique coaxial nozzle, yields an efficient, stand-alone deicing system, i.e. a complete deicing system that reduces glycol usage and deicing cycle time. The new process consists of an inner high velocity stream of glycol surrounded by an outer stream

of high velocity air. These two independent, coaxial streams work in concert to deuce the aircraft surfaces. Laboratory tests have validated that "hybrid deicing" can quickly and safely remove snow and ice frozen to a simulated aircraft surface. These tests indicate that deicing glycol usage can be reduced to 10% or less relative to conventional usage thereby providing the deicing operator with significant economic and waste management benefits. It is estimated hybrid deicing will reduce conventional deicing cycle time, in many deicing situations, by 10% or more providing an additional benefit to the operator. The specially formed stream includes a stream within a stream, wherein a deicing fluid such as glycol is entrained within and encased by a surrounding jacket of entraining fluid such air. Therefore the unique coaxial nozzle produces two essentially independent stream of Type I glycol fluid and air, both stream exiting the nozzle at high and substantially equal velocities in the range of 600 -800 mph. The precise velocity of the streams depends on the upstream pressures and temperatures of the fluids.

This combination of high velocity coaxial stream within a stream of air and glycol hydrodynamically and thermally removes adhered ice, all types of freezing rain and snow. Further the surrounding sheath of forced air reduces the fluid energy and momentum loss of the inner deicing fluid and increases the effective snow/ice removal range (distance from the exit) of the combined streams.

This invention, utilizing high pressure glycol that is coaxially injected into a high velocity airstream, will de-ice aircraft as effectively as the conventional hot glycol wash method but with glycol application rates reduced to 10% or less of conventional rates. Consequently, this new deicing system significantly reduces conventional deicing costs and the impact on the environment.

This combination of high velocity coaxial stream within a stream of air and glycol hydrodynamically and thermally remove adhere ice, and light, wet and heavy snow.

This invention, utilizing high pressure glycol that is coaxially injected into a high velocity airstream and or stream within a stream high pressured injection, will de-ice aircraft as effectively as the conventional hot glycol wash method but with glycol application rates reduced to 10% or less of conventional rates. Consequently, this new deicing system significantly reduces conventional deicing costs and the impact on the environment.

Brief Description of the Drawings

The invention will become more readily apparent from the following description of preferred embodiments thereof, illustrated, by way of examples, in the accompanying drawings, in which:

Fig. 1 is a cross sectional illustration of a prior glycol forced air deicing system showing glycol injection at a right angle to the air stream;

Fig. 2 is an illustration of glycol forced air deicing system in accordance with the present invention showing coaxial glycol injection

Fig. 3 is an illustration of an exit coaxial nozzle in accordance with the present invention showing coaxial glycol injection

Fig. 4 is an illustration of schematic block diagram of a simplified glycol forced air deicing system in accordance with the present invention showing coaxial glycol injection

Fig. 5 is an illustration of the sweeping action found to be effective in the use of the present invention.

Figs. 6a and 6b are illustrations of the frozen snow removal process in accordance with the present invention

Fig. 7 is an illustration of a hybrid glycol forced air deicing system in accordance with the present invention.

Fig. 8 is an illustration of a truck mounted hybrid forced air deicing system in accordance with the present invention.

Fig 9. is an illustration of a stationary boom that can be used with the hybrid forced air deicing system in accordance with the present invention.

Detailed Description Of Preferred Embodiments

Referring now to Fig 2, the new stand-alone ground based hybrid deicing system 10 of the present invention, (shown in detail in Figure 7), utilizes a specially constructed coaxial nozzle assembly 20 that simultaneously delivers two independent, high velocity deicing streams. Preferably, a deicing fluid stream is encased within a high velocity airstream. The nozzle preferably has a special .060 inch diameter jetting orifice that produces a conical shaped jet.

The coaxial nozzle assembly 20 is specially designed to meld two fluid flow technologies, conversion of subsonic airflow to sonic or near sonic airflow and high pressure liquid jetting to create two independent streams that are effective for deicing aircraft. Coaxial nozzle assembly has two concentric pipes along the centerline of the assembly with low and high flow deicing fluid nozzles and a converging/diverging air nozzle.

The coaxial nozzle assembly 20 comprises three concentric cylinders 22, 24, and 26 and three nozzles 32, 34 and 36. This cylindrical arrangement provides two different flow passages for the the deicing fluid and a single passage for the forced air. The outer cylinder 22, with a 3.5 inch internal diameter, has a converging/diverging nozzle 32 at one end 38 where pressurized air 40 exits. Along the centerline of this cylindrical air nozzle 20 are two concentric pipes 24 and 26. The inner pipe 26 delivers high pressure (up to 7000 psi) deicing fluid 42 at approximately 6 gpm to a special fluid jetting nozzle 36 which produces a high velocity deicing fluid jet 44. The inside of the outer pipe 22 and outside of the inner pipe 26 form an annular passage 24 for low pressure deicing fluid in the pressure range of 150-300 psi. The low pressure deicing fluid preferably exits the coaxial nozzle 20 through an annular array of orifices 34 at approximately 20 gpm. The exits of the inner nozzles 34 and 36 are flush with exit of the air nozzle 32.

A key feature of the coaxial nozzle is the compatibility of the exit fluid streams. Pressurized air 40 from a centrifugal compressor (Fig. 7) enters the coaxial nozzle 20 at approximately 100 lb. per minute (ppm). This air 40 exits the coaxial nozzle 20 through the annular region formed by the convergent/divergent nozzle 32 (ASME "long radius" nozzle) and the outer deicing fluid pipe 24.

The ASME nozzle 32 accelerates the air 40 to sonic or near sonic velocity with minimal energy loss. In the low flow mode, high pressure (7000 psi) deicing fluid flows through the inner pipe 26 and exits through a special fluid jetting nozzle 36 in a solid conical pattern. The coaxial nozzle is selected based on the inlet pressures of the air 40 and deicing fluid 42 (high pressure low flow mode) to achieve equal exit velocities of approximately 600-800 mph for both fluids.

Under most deicing conditions, the maximum flow rate of the deicing fluid 42/44 is only 6 gallons per minute (gpm) relative to conventional deicing with flow rates of 60 gpm or more. Since, in the hybrid deicing process, the deicing fluid stream can be, turned "on" or "off" abruptly by the deicing operator, glycol consumption is further reduced. For example, the deicing operator turns "off" the deicing fluid when removing dry or near dry powder snow that is not adhered to the aircraft surface. After deicing under these conditions, the operator can turn "on" the deicing fluid to apply a final overspray of fluid for providing anti-icing holdover time prior to takeoff.

The purpose of the low pressure, high flow deicing fluid feature is to address the fairly infrequent but severe icing conditions that result in the formation of 1/4 inch or more of hard ice frozen to the aircraft surfaces. Under these conditions, a deicing process similar to conventional deicing (hot deicing fluid washdown) must be employed, i.e. thermal removal of the ice. The high velocity air flowing around this lower velocity inner stream assists in the snow removal process and also blows away the steam that forms. Therefore, the airstream has an added benefit of helping the operator to better see what he is doing. For hard, thick ice an operator switches the remote valves to direct the

deicing fluid to the outer annual flow passage and the annular orifice array. The high pressure pump is sped up so that the deicing fluid delivery is increased from 6 gpm to 20 gpm. Since the deicing fluid now flows through a much larger orifice are, the pressure in the annular flow passage drops to 150-300 psi, hence the low pressure high flow mode of operation

Therefore, the hybrid deicing process is adjustable on the spot to the specific deicing conditions encountered and all deicing conditions can be efficiently addressed.. This adjustment capability maximizes effectiveness of the process and is consistent with the goal of this invention to minimize glycol consumption and waste management. Figure 2 below shows the front view of the coaxial nozzle exit and the deicing fluid exit points for the two modes of operation using deicing fluid. A third mode of operation uses air only..

Fig. 3. is an illustration of a front view of a coaxial nozzle exit in accordance with the present invention. ; For most deicing conditions, high velocity low flow deicing fluid 44 is jetted from the center orifice 36 in a conical spray pattern. For hard, thick ice removal, low velocity high flow deicing fluid flows through the annular orifices at a rate of approximately 20 gpm. In both cases, the inner deicing fluid stream 42 is surrounded by a high velocity outer airstream 40.

Fig. 4 is an illustration of schematic block diagram of a simplified glycol forced air deicing system 10 including deicing fluid tank 50 coupled to a high pressure pump 52. A three way selector valve 54 is coupled to the pump 52 to feedback deicer fluid to the tank 50 through return line 55 or to direct deicing fluids 42 and 44 to the nozzle 20. A diverter nozzle 56 is connected between the three way valve 54 and the outer fluid nozzle 44 so that when the diverter valve 56 is open a high volume of low pressure deicing fluid 42/44 flows to the nozzles 32 and 34.

The variable speed system 10 can be used for low flow or high flow operation in which high pressure deicing fluid coaxial to the airstream producing independent streams of fluids that work in concert and are effective in removing wet snow or snow ice that has adhered to the aircraft surfaces.

A coaxial nozzle assembly 20 can be constructed from 3.5 inch diameter stainless steel 30 tubing with a converging/diverging ASME "long radius" nozzle 31 attached to one end. A 24 inch long stainless steel pipe 32, 0.75 inch in diameter, was supported from struts 58 along the centerline of the larger tube 32. A high pressure jetting nozzle assembly 33 can be screwed into the end of this pipe 32. The nozzle assembly 33 can include a carbide nozzle insert 64 that can be changed to alter the deicing fluid jet pattern for example from fan to solid cone with various dispersion angles.

A system in accordance with this schematic having a coaxial nozzle 20 and the remote controlled valves 54 and 56 allows an operator of the deicing system to continuously adjust between all three deicing fluid modes or to select one of three deicing fluid flow modes: i) Low flow (6 gpm) for most deicing conditions, ii) High flow (20 gpm) for hard ice removal or iii) Flow "off for air only removal; deicing fluid is bypassed back to deicing fluid tank.

Fig. 5 is an illustration of the sweeping action found to be effective in the use of the present invention and shows the coaxial nozzle swinging motion found to be the most effective for removing ice. In an actual working system, the coaxial nozzle swinging motion, using an automatic actuation system 74 , can be activated when the deicing fluid 42/44 is called for by for instance depressing the level of the deicing gun (Fig. *).

Figs. 6a and 6b are illustrations of the frozen snow removal process in accordance with the present invention. In Fig. 6a frozen snow is removed by the concentrated energy

of the inner deicing fluid stream. In Fig 6b, both stream work in concert sweep away the loosened frozen snow.

Fig. 7 is an illustration of a hybrid glycol forced air deicing system 10 in accordance with the present invention. A key element of the hybrid deicing system 10 is the compact air source 41, such as a gear driven centrifugal compressor 41, manufactured by AlliedSignal as a model P3X compressor. This compressor 41 is unique because of its very high power density, i.e. its high horsepower to low weight ratio. A high speed radial bladed impeller in this compressor produces pressurized air at 100 ppm at a maximum pressure of 29 psig for sea level operation. These characteristics of the compressor are necessary to provide the air flow rate and discharge pressure at high altitude airports such as Denver International, as well as sea level airports, for effective hybrid deicing. The compactness of the machine allows it to be installed at the base of deicing booms to minimize air handling problems associated with air delivery through large diameter hose and pipe.

High pressure deicing fluid 42/44 is produced by a triplex type positive displacement variable speed pump 70 which has sufficient capacity to pump both low flow (6 gpm), high pressure (7000 psi) and high flow (20 gpm), low pressure (300 psi) deicing fluid. The triplex pump 70 used in the hybrid deicing system has been customized to operate over this wide pressure and flow operating range.

Fig. 8 is an illustration of a truck mounted forced air deicing system in accordance with the present invention. Figure 8 below shows a deicer truck 80 with a hybrid deicing system 10 installed. The equipment shown in this schematic would typically be installed in a deicer truck having a boom 92 (Fig. 8) or a ground mounted boom system 99 (Fig 9.) such as the Ice Hawk system located at the Pittsburgh Airport. A deicing gun 82 including the coaxial nozzle is located at the boom basket 84 and the air compressor 41 is mounted at the base of the boom 80. The air compressor 41 and triplex pump 70 can be hydraulically driven with a diesel (or gasoline) engine 74 as the ultimate power source. A

control system 90 directly associated with the deicing process controls the deicing fluid valves (low flow, high flow or "off") and the speeds of the triplex pump 70 and compressor.

This simple sketch illustrates an important feature of the system 10, namely the location of the compact air source 41 (the gear driven centrifugal compressor) at the base of the deicing boom 82. This location minimizes air handling problems associated with air delivery through large diameter hose and pipe. A Type II antiicing system for gel coating cleaned aircraft, can also be included on the deicing trucks with the hybrid system 10.

Another feature of hybrid deicing, resulting from its reduced deicing fluid usage, is the greater on station availability of the hybrid deicer truck. Typically, a deicer truck 80 has a 2000 gallon Type I deicing fluid tank that is refilled at the airline's maintenance facility usually far removed from where deicing is done, i.e. at the gate or near the takeoff area. Due to its low usage of deicing fluid, a hybrid deicer truck can deice about 10 times the number of aircraft that a convention deicing truck can deice.

Conventional aircraft ground deicing systems consist of ground or truck mounted spray systems which apply hot (180.F) deicing fluid (a mixture of glycol and water) at rates up to 60 gpm to the aircraft surfaces. This thermal process is very effective in quickly melting the snow or ice from these surfaces, i.e. wings, etc. However, glycol is expensive and toxic creating significant economic and waste management problems for airline and airport operators. This invention addresses a lab-tested, stand-alone hybrid deicing system built around a coaxial nozzle. An independent, high energy, low flow deicing fluid stream within a high velocity airstream does much of the work to break loose ice and frozen snow from aircraft surfaces or to move heavy, wet snow. A significant savings to airline operators in reduced glycol usage, greater on station availability of deicer trucks, and reduced waste management problems are the benefits of this new hybrid deicing process.

In operation it has been determined that the combination of compatible high velocity coaxial streams of air and heated deicing fluid can be used to hydrodynamically and thermally remove adhered ice/snow and heavy, wet snow. a deicing fluid (glycol/water mixture) can be heated and injected in the center of the airstream through a special .060 inch diameter jetting orifice at pressures up to 7,000 psi creating a conical shaped inner fluid stream of high velocity fluid which quickly penetrates and breaks loose ice and snow frozen to the aircraft surfaces. The concentrated force of this high velocity fluid stream is very effective in moving heavy, wet snow. The outer sheath of high velocity air then works in concert with the inner stream of deicing fluid to hydrodynamically sweep away the ice and snow.

Increased aerodynamic sweeping action of the high velocity airstream is achieved by adding to it an inner stream within a stream, either and or by adding to it a high velocity coaxial stream of hot air glycol, or water dilute hot glycol. This combination of inner stream within a stream and or of high velocity coaxial streams of air and glycol hydronomically and thermally remove adhere ice, wet, light and heavy snow. The glycol is injected in the center of the airstream through a .060 inch diameter nozzle orifice at pressures up to 7,000 psi creating a dense and or highly condensed inner core of high velocity fluid which quickly penetrates and breaks loose ice and snow frozen to the aircraft surfaces. The outer sheath of high velocity coaxial stream and or stream within a stream then works in concert with the inner stream of glycol to hydronimically sweep away the ice and snow. Since the maximum flow rate of the glycol is only 6 gallons per minute (gpm) and the glycol stream can abruptly turned on or off by the deicing operator, glycol consumption is greatly reduced relatively to glycol consumption for conventional deicing. The deicing operator turns on the glycol stream only when required by the deicing conditions, i.e. localized patches adhered ice/snow. Also, the operator can apply a final overspray of glycol after deicing, a conventional practice, for providing anti-icing prior to takeoff.

In summary, the hybrid forced air/glycol deicing is a that produces coaxial stream of high velocity air and glycol either and or high velocity stream within a stream that in combination have momentum and kinetic energy that are at least 50% higher than these same characteristics for the prior art fluid "spray pattern". The prior art injects glycol transverse to the fluid "spray pattern" which does not change the momentum, but the kinetic energy is reduced. Fluid "stream within a stream" momentum is the primary mechanism for sweeping away loose snow and ice. Kinetic energy is the mechanism for breaking loose snow and ice that is frozen to the aircraft surfaces. Therefore, ample fluid "stream within a stream and or coaxial stream" momentum and kinetic energy are necessary to provide effective deicing under all weather and deicing conditions.

While the sketches, illustrations and detailed descriptions disclosed the particulars, general and specific attributes of the embodiment of the method, apparatus and systems of the invention, it should not be construed nor assumed by anyone and or those skilled in the art that it is not a form or aspects of limitation of the said and described invention. The details are a mere attempt, for the purpose of clarifications and to express ideas, to explain the principles, to aid and guide an individual/s with expertise in the field to visualize the concepts of said invention. As a plurality of modifications and variations of the present invention are probable and possible taking into consideration the disclosure of the sketches, illustrations and detailed descriptions, it should be understood that the citing, teaching and referring to some and all equivalent elements or combinations for achieving substantially the same results may be practiced otherwise than as uniquely and precisely explicated and described.

What is claimed is:

1. A pressurized hybrid system for deicing ice covered surface comprising:

a first source of deicing fluid

second source of deicing fluid

first pressurizer coupled to the first source of deicing fluid for supplying a pressurized deicing fluid at velocities in excess of 600 mph.

second pressurizer coupled second source of deicing fluid for supplying a pressurized deicing fluid at velocities in excess of 600 mph.

a dual flow concentric nozzle coupled to said first and second sources of deicing fluid through said first and second pressurizes, said a dual flow nozzle includes two separate passages for combining fluids from said first and second sources as a stream within a stream fluid and

a nozzle control for directing the stream toward an ice covered surface to dislodge accumulated ice from the surface.

2. The pressurized hybrid deicing system of claim 1 wherein the ice covered surface is an aircraft.

3. The pressurized hybrid deicing system of claim 1 wherein the concentric passages of the dual flow nozzle are substantially co-planar at the nozzle exit.

4. The pressurized hybrid deicing system of claim 1 wherein the concentric passages of the dual flow nozzle are substantially concentric about a common center line.

5. The pressurized hybrid deicing system of claim 1 wherein the first source of deicing fluid comprises an entraining fluid selected from the group including air, water and inert gas and the second source of deicing fluid is selected from the group including: glycol (type I), glycol (type I) and glycol diluted with water.

6. The pressurized hybrid deicing system of claim 1 wherein the dual flow nozzle includes a first passage encasing the second passage.

7. The pressurized hybrid deicing system of claim 1 wherein the second passage comprises a thick walled pipe.

8. The pressurized hybrid deicing system of claim 1 further including a third passage encased within the second passage, said third passage being coupled to the glycol supply for supplying a central glycol stream.

9. The pressurized hybrid deicing system of claim 8 wherein the second passage comprises a thin walled pipe.

10. The pressurized hybrid deicing system of claim 8 wherein the three separate passages are concentric a common center line.

11. The pressurized hybrid deicing system of claim 8 wherein the three separate passages converge a the nozzle exit.

12. The pressurized hybrid deicing system of claim 8 wherein the three separate passages are substantially coplanar at the nozzle exit.

13. The pressurized hybrid deicing system of claim 8 wherein glycol flows in the second and third passages and air flows in the first passage.

14. The pressurized hybrid deicing system of claim 5 wherein the glycol and air streams are substantially independent.

15. The pressurized hybrid deicing system of claim 5 wherein the glycol and air streams exit the nozzle at approximately the same velocities and as substantially independent streams.

16. The pressurized hybrid deicing system of claim 1 wherein the second source of deicing fluid is selected from the class comprising glycol (type I), glycol (type I) and glycol diluted with water.

17. The pressurized hybrid deicing system of claim 1 wherein the first deicing fluid is heated.

18. The pressurized hybrid deicing system of claim 1 wherein the second deicing fluid is heated.

19. The pressurized hybrid deicing system of claim 1 wherein the deicing fluid is diluted with water.

20. The pressurized hybrid deicing system of claim 1 wherein the first pressurizer is a centrifugal compressor.

21. The pressurized hybrid deicing system of claim 1 wherein the first pressurizer supplies the pressurized fluid at velocities in excess of 600 ft/sec.

22. The pressurized hybrid deicing system of claim 1 wherein the first pressurizer supplies the pressurized fluid at velocities in the range of 600 to 800 mph.

23. The pressurized hybrid deicing system of claim 1 wherein the second pressurizer comprises a triplex pump.

24. The pressurized hybrid deicing system of claim A wherein second pressurizer provides glycol flows in the range of 6 gpm @ 7000 psi to 20 gpm @ 300 psi.

25. The pressurized hybrid deicing system of claim 1 wherein the systems adapted for usage on a moving vehicle.

26. The pressurized hybrid deicing system of claim 25 wherein vehicle is a truck.

27. The pressurized hybrid deicing system of claim 26 wherein the vehicle includes a boom for mounting.

28. The pressurized hybrid deicing system of claim 1 wherein the a dual flow concentric nozzle long radius nozzle.

29. The pressurized hybrid deicing system of claim 1 wherein the system includes a first controllable valve is coupled between the soũrce of deicing fluid and the nozzle to regulate the flow of deicing between fluid high pressure low/flow mode and low pressure high flow

30. The pressurized hybrid deicing system of claim 1 wherein the second deicing fluid is discharged from the nozzle a central jets stream.

31. The pressurized hybrid deicing system of claim 30 wherein second deicing fluid is encased in a stream of second

32. The pressurized hybrid deicing system of claim 1 wherein nozzle has a 0.060 inch diameter and provides a deicing fluid flow approximately 6 gpm.

33. The pressurized hybrid deicing system of claim 1 wherein nozzle has a carbide tip

34. The pressurized hybrid deicing system of claim 5 the glycol and air are simultaneously supplied

35. The pressurized hybrid deicing system of claim 34 further including a valve for adjusting the flow of the first deicing fluid.

36. The pressurized hybrid deicing system of claim 35 further including a boom and wherein the deicing fluid control valve is mounted on the boom

37. The pressurized hybrid deicing system of claim 1 wherein the coaxial nozzle combines two fluid flow technologies, conversion of subsonic airflow to sonic airflow and high pressure liquid jetting, to produce two compatible and coaxial streams of air and deicing fluid at flow rates of 100 ppm and 6 gpm, respectively.

38. The pressurized hybrid deicing system of claim 1 the two compatible, yet independent, fluid streams exit the coaxial nozzle at equal velocities of 800 mph.

39. The pressurized hybrid deicing system of claim 38 wherein the inner stream of energetic deicing fluid provides the force necessary to break loose frozen snow and ice from aircraft surfaces and to also move heavy, wet snow and the outer sheath of high velocity air then works in concert with this inner stream to hydrodynamically sweep away the ice and snow.

40. The pressurized hybrid deicing system of claim 1 wherein the coaxial nozzle includes an annular exit region formed by a converging/diverging nozzle for discharging the outer airstream exits the nozzle through

41. The pressurized hybrid deicing system of claim 1 wherein the coaxial nozzle includes an inner pipe assembly installed along the centerline of the air nozzle.

42. The pressurized hybrid deicing system of claim 1 wherein the converging/diverging nozzle efficiently accelerates the subsonic airflow to near sonic velocity.

43. The pressurized hybrid deicing system of claim 1 wherein the coaxial nozzle produces two substantially equal, high velocity streams exiting from a common plane and moving in the same direction.

44. The pressurized hybrid deicing system of claim 1 wherein the coaxial nozzle has two smaller pipes, one concentric to the other, along the centerline of the air nozzle wherein a high pressure in the range of 7000 psi of deicing fluid flows through the inner pipe and exits through a 0.060 inch diameter jetting nozzle at 6 gpm.

45. The pressurized hybrid deicing system of claim 44 wherein the exit of this jetting nozzle is coplanar with the exit of the air nozzle which increases the compatibility of these fluid streams,

46. The pressurized hybrid deicing system of claim 45 wherein the two streams exiting the nozzle join with equal velocities.

47. The pressurized hybrid deicing system of claim 5 wherein the outer sheath of high velocity air minimizes dispersion of the inner fluid stream helping to maintain the concentrated momentum of the inner deicing fluid stream

48. The pressurized hybrid deicing system of claim 47 wherein the momentum of this inner stream is concentrated by the special high pressure jetting nozzle into a solid conical jet that is approximately 1 ft. in diameter at the 4 to 6 ft. working distance.

49. The pressurized hybrid deicing system of claim 1 wherein the deicing fluid in the inner stream is heated to 180°F so that the hydrodynamic sweeping action is augmented by thermal removal of ice and snow.

50. The pressurized hybrid deicing system of claim 49 wherein the nozzle includes an annular path between the two inner, concentric pipes for a second deicing fluid stream.

51. The pressurized hybrid deicing system of claim 50 wherein the deicing fluid heated to a temperature of approximately 180°F is supplied to the annular path by an operator

52. The pressurized hybrid deicing system of claim 51 wherein activated remotely controlled valve controls the supply of the heated deicing fluid.

53. The pressurized hybrid deicing system of claim 52 wherein the heated deicing fluid exits the coaxial nozzle at 20 gpm through an annular array of orifices coplanar with the other two nozzles wherein the outer sheath of high velocity air is present in this mode of deicing designed to remove hard, thick ice by the conventional thermal process.

54. The pressurized hybrid deicing system of claim 1 further including remotely controlled valves that allow the operator to select any of three deicing operation modes selected from the class comprising: i) low flow (6 gpm), high velocity deicing fluid for most deicing conditions, ii) high flow (20 gpm), low velocity deicing fluid for hard, thick ice, and iii) high velocity air only for dry snow not adhered to the aircraft surfaces.

55. The pressurized hybrid deicing system of claim 1 wherein further embodiment of hybrid deicing is the use of a gear driven centrifugal compressor having ample discharge pressure and airflow to provide effective hybrid deicing at high altitude airports.

56. The pressurized hybrid deicing system of claim 55 wherein the gear driven compressor is installed at the base of a deicing boom to minimize air handling problems associated with air delivery through large diameter hose and pipe.

57. The pressurized hybrid deicing system of claim 1 wherein the high pressure deicing fluid is supplied by a customized triplex-type positive displacement pump which has sufficient capacity to pump fluid at both low flow of approximately 6 gpm, high pressure of approximately 7000 psi condition and high flow of approximately 20 gpm, low pressure of approximately 300 psi condition.

58. A pressurized hybrid system for deicing aircraft comprising:

a source of glycol based deicing fluid,

a high pressure pump for supplying glycol at velocities in excess of 600 mph.,

a source of pressurized air,

a dual flow nozzle coupled to said supply of pressurized glycol and pressurized air, said a dual flow nozzle includes two separate passages for combining glycol and air as a glycol stream encased within a within an air stream.

59. The pressurized hybrid deicing system of claim 58 wherein the two separate passages converge a the nozzle exit.

60. The pressurized hybrid deicing system of claim 58 wherein the two separate passages are annular.

61. The pressurized hybrid deicing system of claim 58 wherein the two separate passages are concentric a common center line.

62. The pressurized hybrid deicing system of claim 58 wherein the first passage encases the second passage.

63. The pressurized hybrid deicing system of claim 58 further including a third passage encased within the second passage, said third passage being coupled to the glycol supply for supplying .

64. The pressurized hybrid deicing system of claim 63 wherein the three separate passages are concentric a common center line.

65. The pressurized hybrid deicing system of claim 58 wherein the three separate passages converge a the nozzle exit.

66. The pressurized hybrid deicing system of claim 58 wherein the three separate passages are substantially coplanar at the nozzle exit.

67. The pressurized hybrid deicing system of claim 63 wherein glycol flows in the second and third passage and air flows in the first passage.

68. The pressurized hybrid deicing system of claim 58 wherein the glycol and air streams are substantially independent

69. The pressurized hybrid deicing system of claim 58 wherein the glycol and air streams are traveling at approximately the same velocities exiting the nozzle are substantially independent

70. The pressurized hybrid deicing system of claim 58 further including nozzle control for directing the deicing stream toward an ice covered surface to dislodge accumulated ice from the surface.

71` A Method for deicing an ice covered surface comprising

providing a first source of deicing fluid

providing second source of deicing fluid

pressurizing the first source of deicing fluid for supplying a pressurized deicing fluid at velocities in excess of 600 ft/sec.

pressurizing the second source of deicing fluid for supplying a pressurized deicing fluid at velocities in excess of 600 ft/sec.

coupling a nozzle to said first and second sources of pressurized deicing fluid for combining fluids from said first and second sources as a stream within a stream

72. The method for deicing of claim 71 further including the step of directing the stream within a stream toward an ice covered surface to dislodge accumulated ice.

73. The method for deicing of claim 71 wherein the nozzle comprises a dual flow nozzle having passages that are substantially co-planar at the nozzle exit.

74. The method for deicing of claim 71 wherein the passages of the dual flow nozzle are substantially concentric about a common center line.

75. The method for deicing of claim 71 wherein the nozzle comprises three separate passages are substantially coplanar at the nozzle exit.

76. The method for deicing of claim 71 wherein glycol flows in the second and third passages and air flows in the first passage.

77. The method for deicing of claim 71 wherein the glycol and air streams are substantially independent.

78. The method for deicing of claim 77 wherein the glycol and air streams exit the nozzle at approximately the same velocities and as substantially independent streams.

79. The method for deicing of claim 71 wherein the step of pressurizing the first source of deicing fluid for supplies the pressurized fluid at nozzles velocities in the range of 600 to 800 mph.

80. The method for deicing of claim 71 wherein the step of pressurizing the first source of deicing fluid for supplies the pressurized fluid at nozzles velocities in the range of 600 to 800 mph.

81. The method for deicing of claim 71 wherein the step of pressurizing the first source of deicing fluid provides glycol flows in the range of 6 gpm @ 7000 psi to 20 gpm @ 300.

82. The method for deicing of claim 71 further including the step of controlling the flow of deicing fluid to the nozzle to regulate the flow of deicing between fluid high pressure low/flow mode and low pressure high flow mode.

83. The method for deicing of claim 71 further including the step of supplying a stream of energetic deicing fluid with a force necessary to break loose frozen snow and ice from iced surfaces and to also move heavy, wet snow and outer sheath of high velocity air to work in concert with this inner stream to hydrodynamically sweep away the ice and snow.

84. The method for deicing of claim 71 further including the step of efficiently accelerating a subsonic airflow to sonic velocity.

85. The method for deicing of claim 71 further including the step of applying an outer sheath of high velocity air to maintain the concentrated momentum of the inner deicing fluid stream

86. The method for deicing of claim 71 further including the step of concentrating the deicing fluid into a solid conical jet that is approximately 1 ft. in diameter at the 4 to 6 ft. working distance.

87. The method for deicing of claim 71 further including the step of heating the deicing fluid in the range of 180°F so that the hydrodynamic sweeping action is augmented by thermal removal of ice and snow.

88. The method for deicing of claim 71 further including the step of continuously cycling the deicing fluid to maintain heat fluid ready for discharge.

89. The method for deicing of claim 71 further including the step of abruptly turning controlling change from glycol flow to no glycol flow to reduce significantly glycol consumption.

ABSTRACT:

Hybrid Deicing System And Method Of Operation

This invention overcome the disadvantage of the prior systems and produces a high velocity specially formed and constituted pressure aerodynamic stream for efficiently and effectively removing ice from an aircraft. The specially formed stream includes a stream within a stream, wherein a deicing fluid such a glycol is entrained within and encased by a surrounding jacket of entraining fluid such air. This deicing is now known as coaxial stream/stream within a stream deicing. The special nozzle allows the stream to maintain fluid separation over its flight path so that aircraft contact is made by to be known as coaxial stream/stream within a stream deicing. The coaxial stream/stream within a stream deicing is further enhanced by pressurizing the stream to deliver the stream as a high pressure high velocity stream to improved the aerodynamic sweeping action of the airstream

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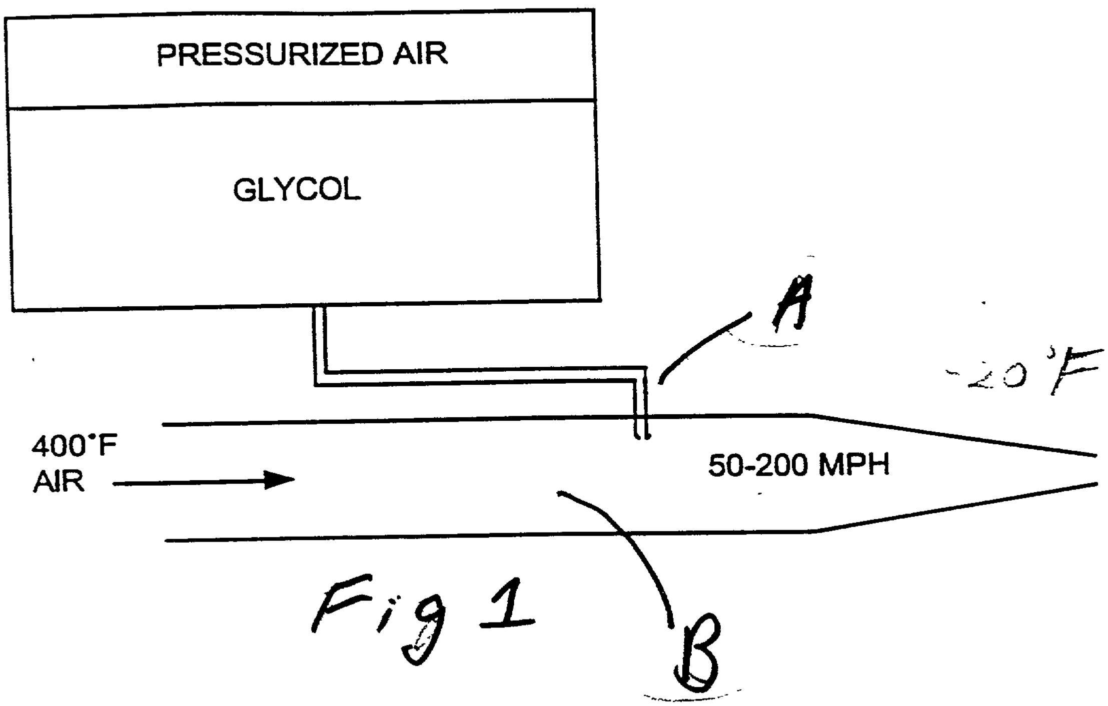


Fig 1

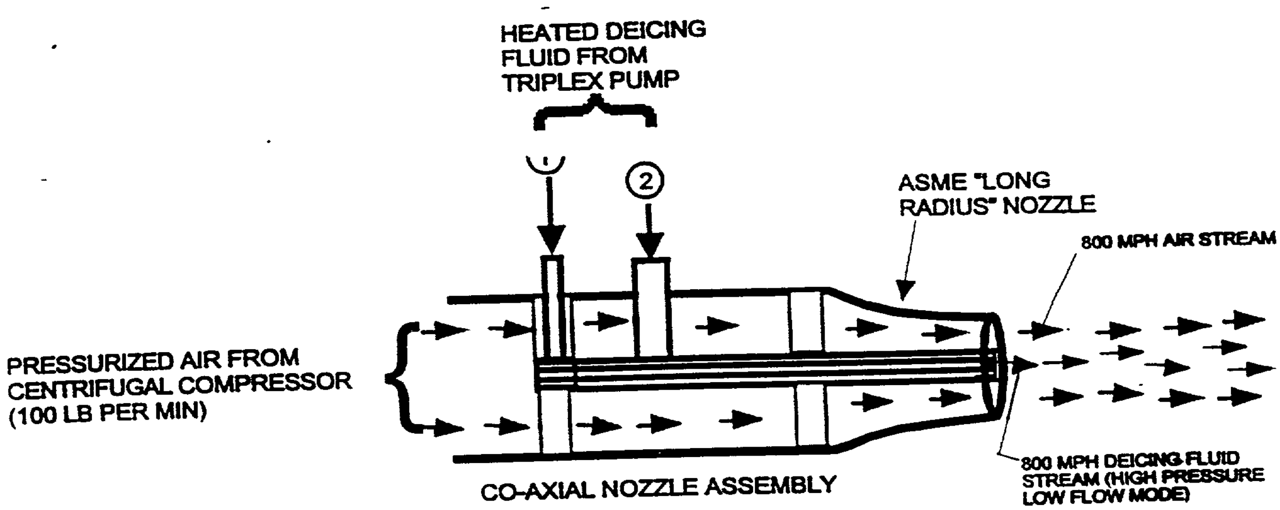


Fig 2

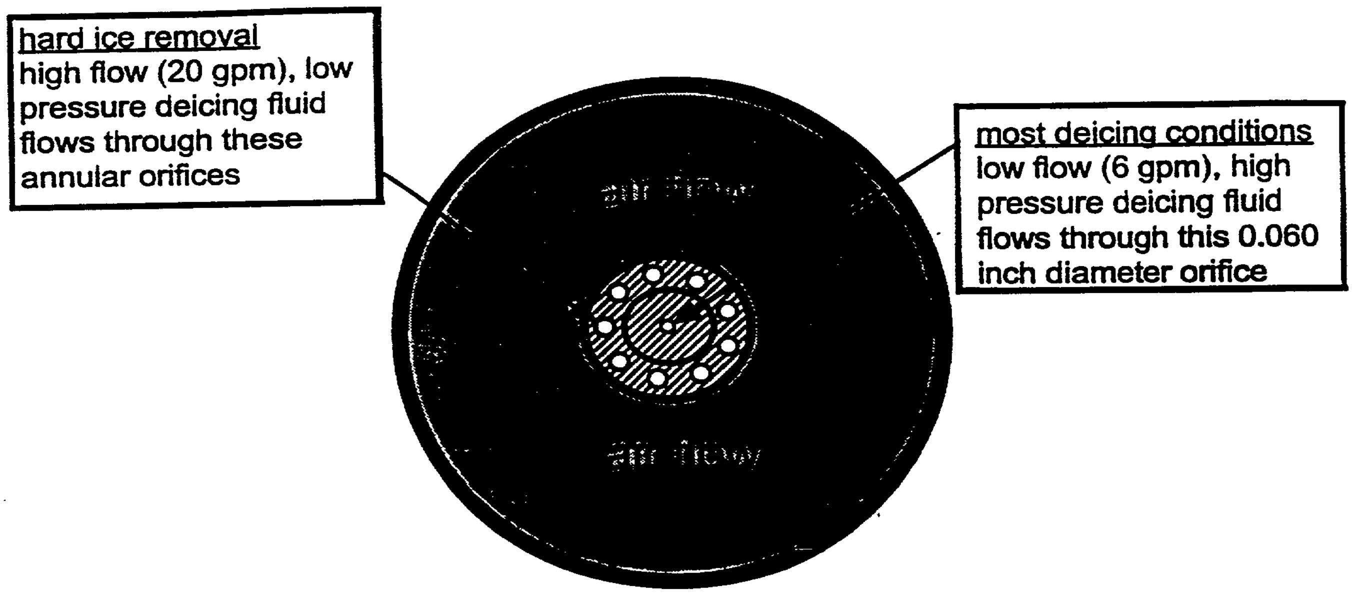
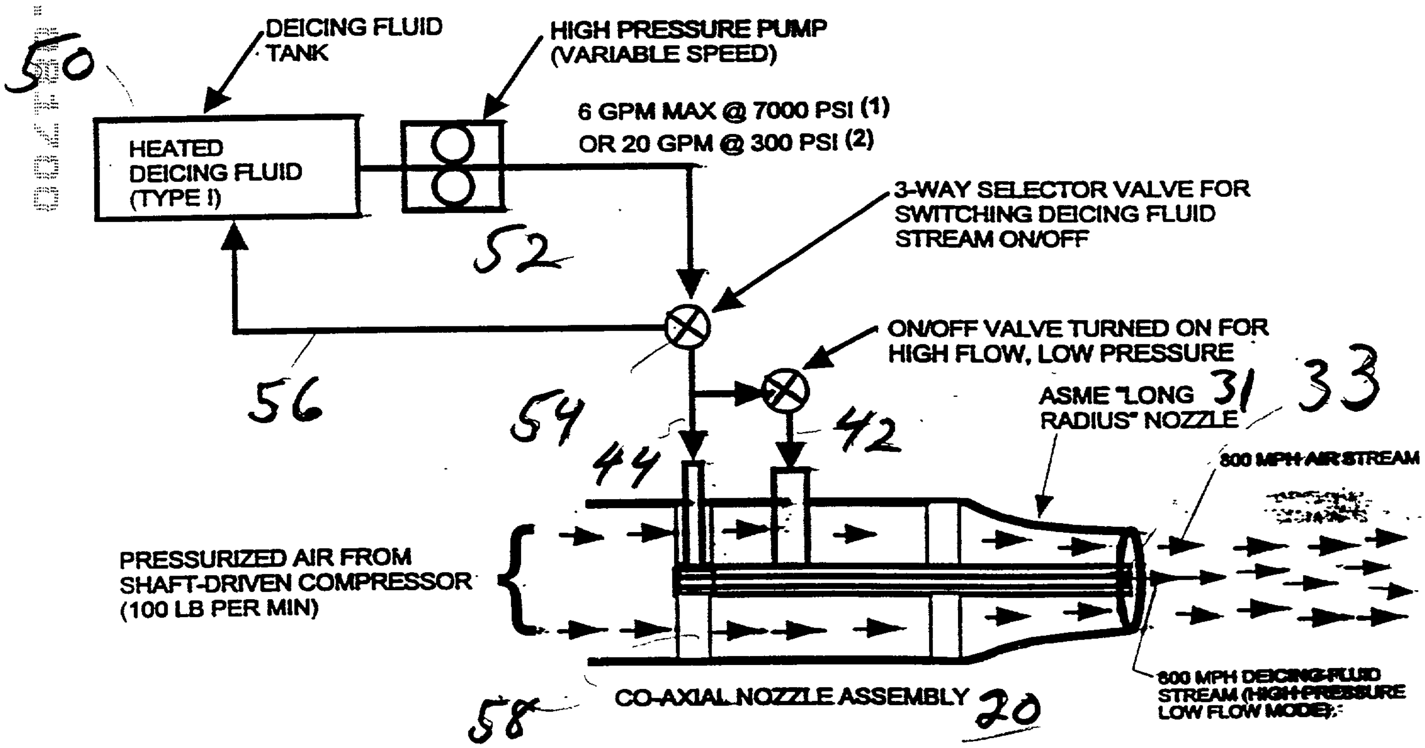


Fig 3



1) HIGH PRESSURE/LOW FLOW MODE (MOST DEICING CONDITIONS)
2) LOW PRESSURE/HIGH FLOW MODE (HARD, THICK ICE)

Fig 4

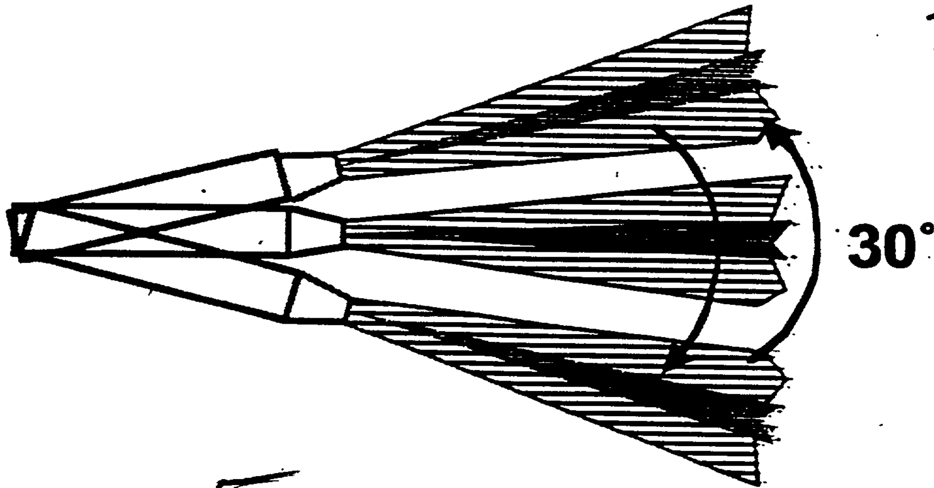

30°

Fig 5

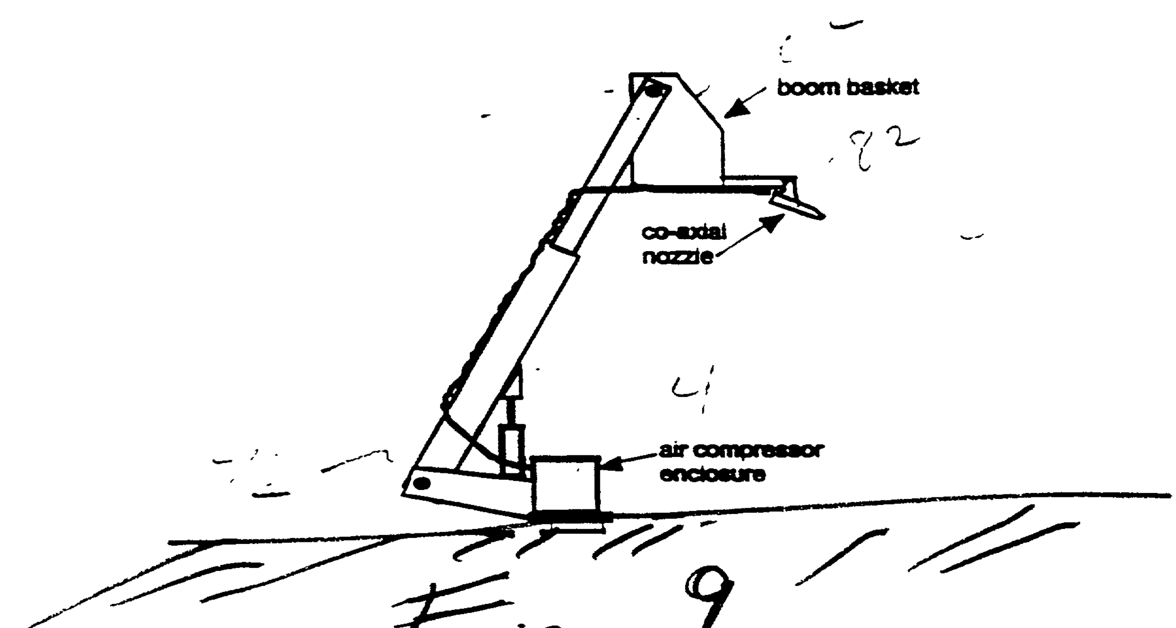

boom basket
82
co-axial
nozzle
4
air compressor
enclosure

Fig 9

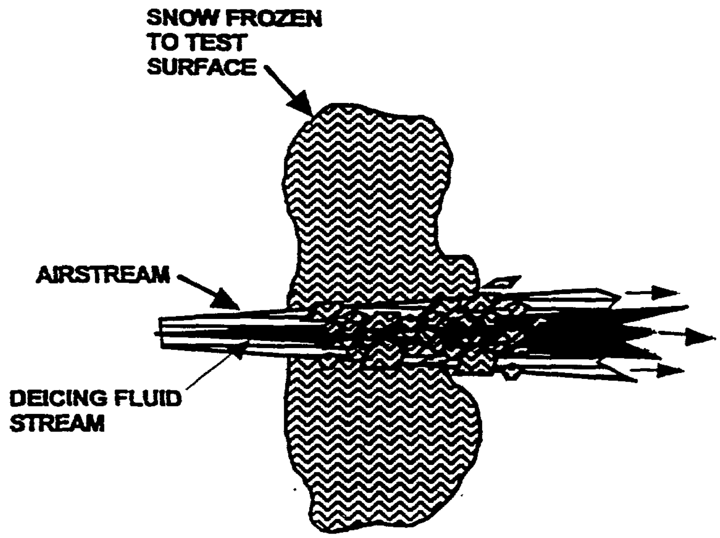


Fig. 6a. Frozen Snow Removal Process. *The concentrated energy of the inner deicing fluid stream breaks loose the frozen snow.*

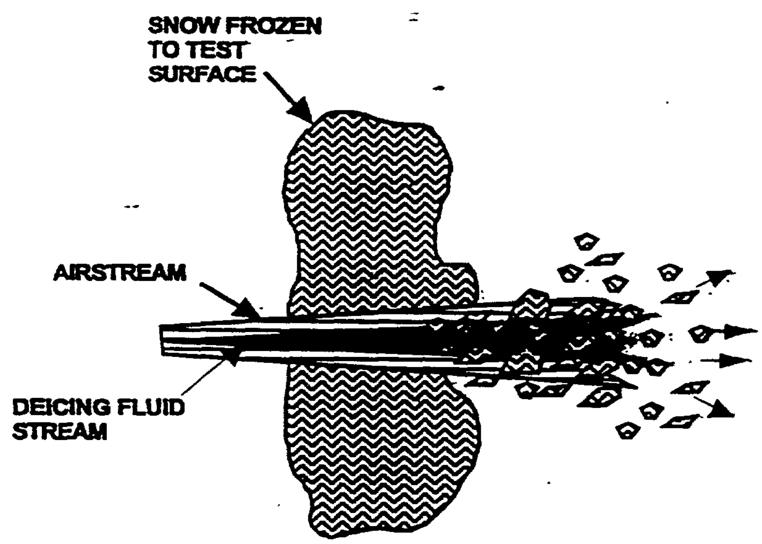


Fig. 6b. Frozen Snow Removal Process. *Both fluid streams work in concert to sweep away the loosened frozen snow.*

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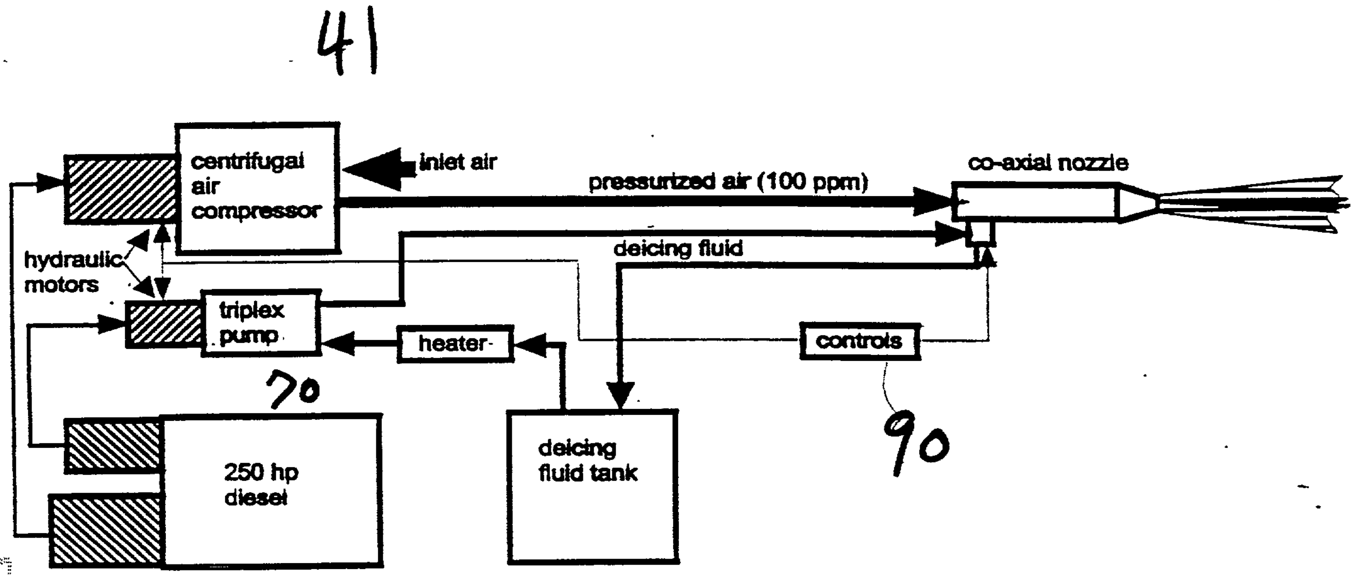

Fig 7

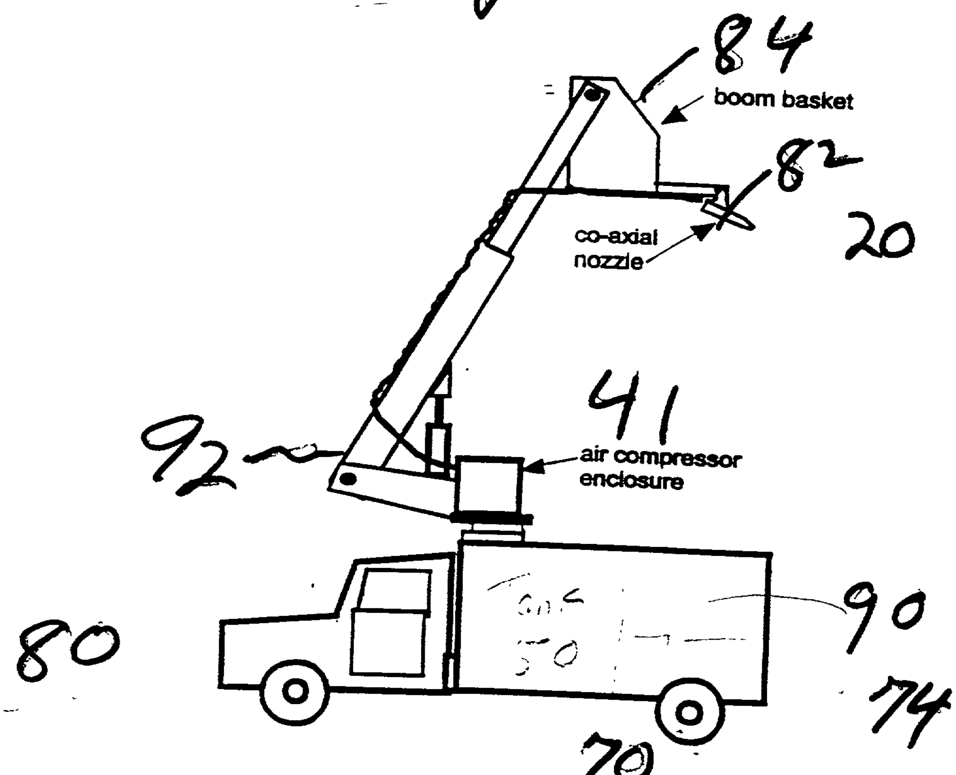

Fig. 8. Deicer Truck with Hybrid Deicing System. *The compactness of the air compressor allow it to be located at the base of the deicing boom.*

COMBINED DECLARATION FOR PA[illegible] APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)	Attorney's Docket Number 050-96-017	.pplication No. (if known) 08/877,272

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

HYBRID DEICING SYSTEM AND METHOD OF OPERATION

the specification of which

☐ is attached hereto

OR

☒ was filed as United States Application Number or PCT International Application Number

08/877,272

on 06/17/97

and was amended

on herewith (if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim the benefit under Title 35, United States, §119 (e) of any United States provisional application(s) listed below.

60/022,508	06/28/96
(Application Number)	(Filing Date)
(Application Number)	(Filing Date)

I hereby claim foreign priority benefits under Title 35, United States Code, §119 (a)-(d) or §365 of any foreign application(s) for patent or inventor's certificate or §365 (a) of any PCT international application(s) which designated at least one country other than the United States of America, listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:

COUNTRY (if PCT, indicate "PCT")	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 USC 119
			☐YES ☐NO
			☐YES ☐NO
			☐YES ☐NO
			☐YES ☐NO
			☐YES ☐NO
			☐YES ☐NO

Combined Declaration For Patent Application and Power of Attorney (Continued)
(Includes Reference to PCT International Applications)

ATTORNEY'S DOCKET NUMBER:
050-96-017

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or §365 of any PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56 which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. 120:

U.S. APPLICATIONS			STATUS (Check one)		
U.S. APPLICATION NUMBER	U S. FILING DATE		PATENTED	PENDING	ABANDONED
PCT APPLICATIONS DESIGNATING THE U.S.					
PCT APPLICATION NO.	PCT FILING DATE	U.S. SERIAL NUMBERS ASSIGNED *(if any)*			

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. *(List name and registration number)* Robert Desmond, Reg. No. 38,430; Larry Palguta, Reg. No. 29,575; Jeanne C. Suchodolski, Reg. No. 34,936; Jerry Holden, Reg. No. 34,182; and Roger H. Criss, Reg. No. 25,570, all attorneys with AlliedSignal Inc., 2525 West 190th Street, Torrance, California 90504-6099

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	POST OFFICE ADDRESS	POST OFFICE ADDRESS	CITY	STATE & ZIP CODE/COUNTRY

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

SIGNATURE OF INVENTOR 201 John Stanko	SIGNATURE OF INVENTOR 202 Lowell W Pearson	SIGNATURE OF INVENTOR 203
DATE 4·3·99	DATE 4-6-99	DATE

Combined Declaration For Patent Application and Power of Attorney (Continued) (Includes Reference to PCT International Applications)	ATTORNEY'S DOCKET NUMBER 050-96-017

204	FULL NAME OF INVENTOR	FAMILY NAME	FIRST GIVEN NAME	SECOND GIVEN NAME
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	POST OFFICE ADDRESS	POST OFFICE ADDRESS	CITY	STATE & ZIP CODE/COUNTRY
205	FULL NAME OF INVENTOR	FAMILY NAME	FIRST GIVEN NAME	SECOND GIVEN NAME
	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP
	POST OFFICE ADDRESS	POST OFFICE ADDRESS	CITY	STATE & ZIP CODE/COUNTRY
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	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP
	POST OFFICE ADDRESS	POST OFFICE ADDRESS	CITY	STATE & ZIP CODE/COUNTRY

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

SIGNATURE OF INVENTOR 204	SIGNATURE OF INVENTOR 205	SIGNATURE OF INVENTOR 206
DATE	DATE	DATE